CompreX: XML Compression and the Airborne Internet

Kirk Swanson, Jason Judt
Architecture Technology Corporation
May 4, 2005

Introduction

- Airborne Internet
  - What is it?
  - Environment
- XML
  - What is it?
  - Properties and characteristics
- CompreX
  - Our approach to the problem
  - Initial results

The Airborne Internet: What *is* it?

- Many possible definitions; widely varying concepts including:
  - "Last mile" internet connectivity using airborne network assets
  - Broadband connectivity provided to airline passengers
  - Augmented communication, navigation and surveillance information to pilots
- Airborne Internet Consortium definition: "a private, secure and reliable peer-to-peer aircraft communications network that uses the same technology as the commercial Internet"

The Airborne Internet: What *is* it?

- Our definition: Any implementation which connects aircraft to a ground-based Internet access node, including the information which is passed across this communication link
- Provides airborne access to wealth of Internet information and resources
  - Convenience: flight planning, en route reservations, travel arrangements
  - Safety: weather, surrounding airspace environment, aircraft-to-aircraft communications
  - Security: flight tracking/deviation monitoring, in-flight video monitoring, cockpit voice/video recording

The Airborne Internet: Environment

- Compare/contrast to ground-based Internet:

		Environment	
		Ground-Based	**Airborne**
Attribute / Resource	**Bandwidth**	"unlimited" (Gbps)	highly restrictive (~kbps)
	Communication Latency	"zero" (ms)	significant (tenths of seconds)
	Computational Power	"unlimited" distributed, multi-processor, high-availability	limited avionics designed for aircraft specific uses

XML: What *is* it?

- XML (Extensible Markup Language) is:
  - Human readable, machine processable data representation format
  - “Dialect” of the Standard Generalized Markup Language (SGML)
  - Application and operating system independent
  - Assuming an increasingly important role in exchange of Web based services and information
- XML has become the de facto standard in Web services interactions

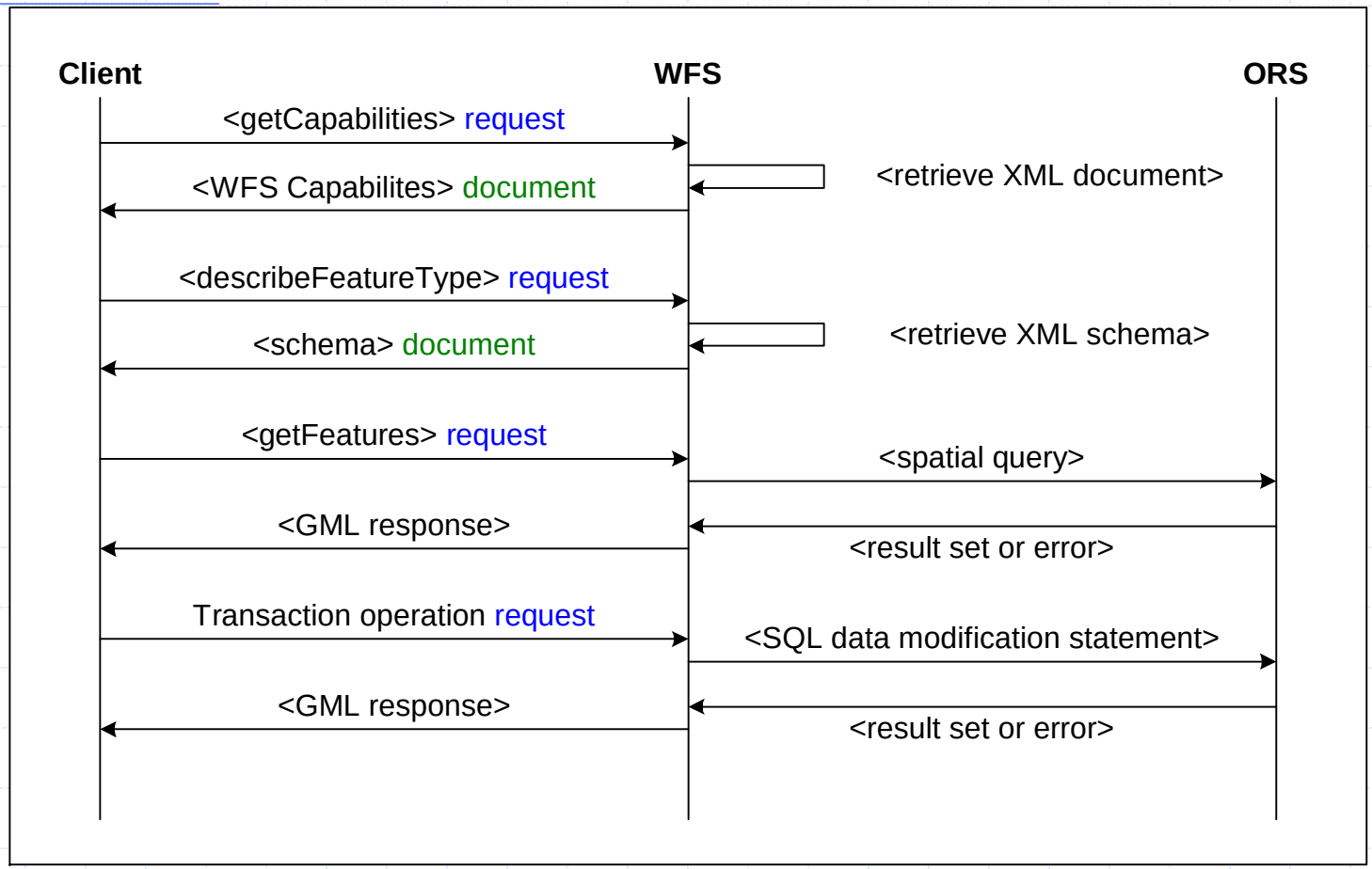
XML: Properties and Characteristics

- XML utilizes:
  - Standard protocols (HTTP, SMTP, etc)
  - Standard data representation format (SOAP)
  - Standard description languages (XML Schema), which form the framework allowing application of desired information to correct implementatin
  - A standard discovery mechanism (UDDI)

XML: The Language

<?xml version="1.0" ?>
<!--NAV23 flight plan-->
<!DOCTYPE FLIGHTPLAN *(View Source for full doctype...)*>
<FLIGHTPLAN TITLE="**Gran Canaria - Tenerife**" DESCRIPTION="**GCLP, GCTS**" DATE="**29/10/00**" AUTHOR="**Anonymous**"
FLIGHTPLANNERTOOL="**NAV23**" DESIREDFLSIM="**All**">
<PLANE NAME="**Casa CN235**" CRUISEALTITUDE="**8000**"
DESCENTFUEL="**10**" CLIMBFUEL="**20**" CRUISEFUEL="**14**"
SPEEDUNITS="**knots**" CRUISESPEED="**140**" CLIMBSPEED="**250**"
DESCENTSPEED="**120**" CLIMBRATE="**1250**" DESCENTRATE="**1250**" />
<DEPARTURE TYPE="**RUNWAY**" ICAO="**03R-21L**" NAME="**Pista 03R-21L**" LATITUDE="**27.9311930412178**" LONGITUDE="**-15.3846144676208**"
ALTITUDE="**76.9999646765041**" />

Typical XML Web Service Transaction

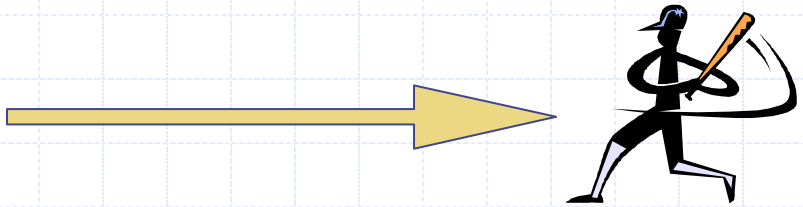


WFS: Web Feature Server ORS: Obstruction Repository System

XML: The Down Side

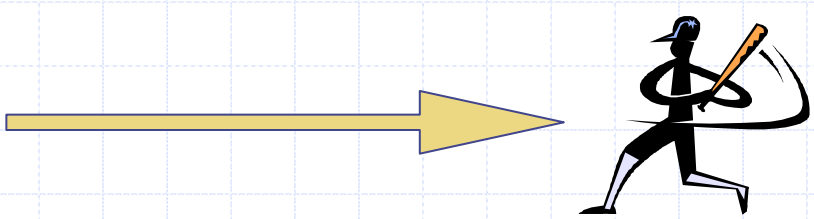
- All this power and interoperability comes at a price:
  - Message size is increased dramatically (3-10x of original)
  - Client/server interactions are increased significantly (many communication transactions to get/send single piece of information)
  - Computational resources necessary for message parsing and processing

XML in the AI Environment



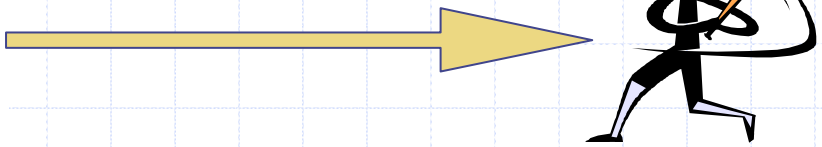
STRIKE 1

Low Bandwidth



STRIKE 2

High Latency



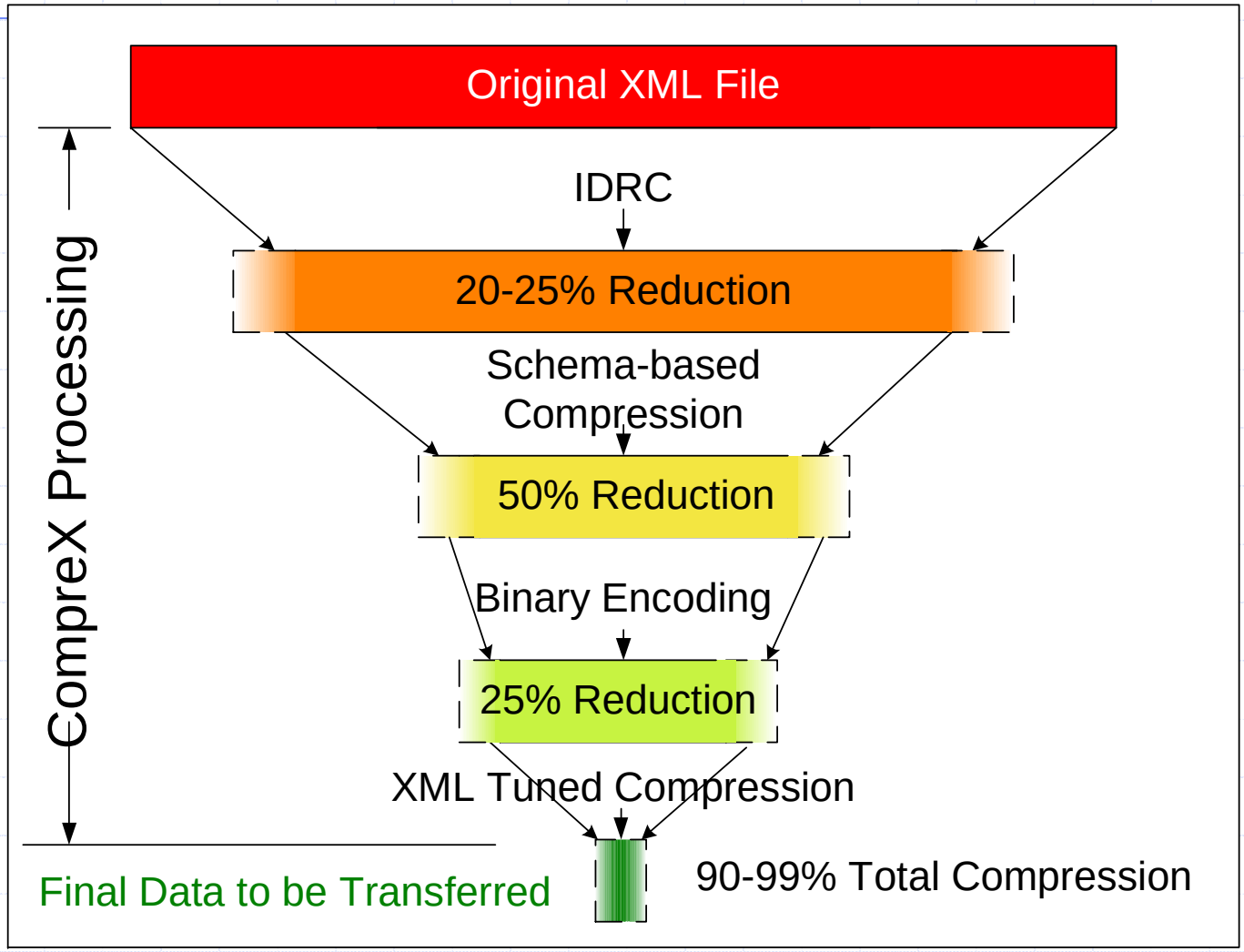
STRIKE 3

Limited Resources

CompreX

- 4-prong approach to XML compression:
  - Inter-Document Redundancy Compression (IDRC)
  - Schema-based compression
  - XML-binary encoder
  - XML-tuned compression algorithm
- Work together as a unit; output from one process used as input to subsequent process for cumulative compression effects
- Seamless integration with existing web services
  - Fast and efficient compression required
  - Near real-time, on-the-fly operations needed
  - Transparent to end-user (aside from boosted performance)

CompreX: Process Flow



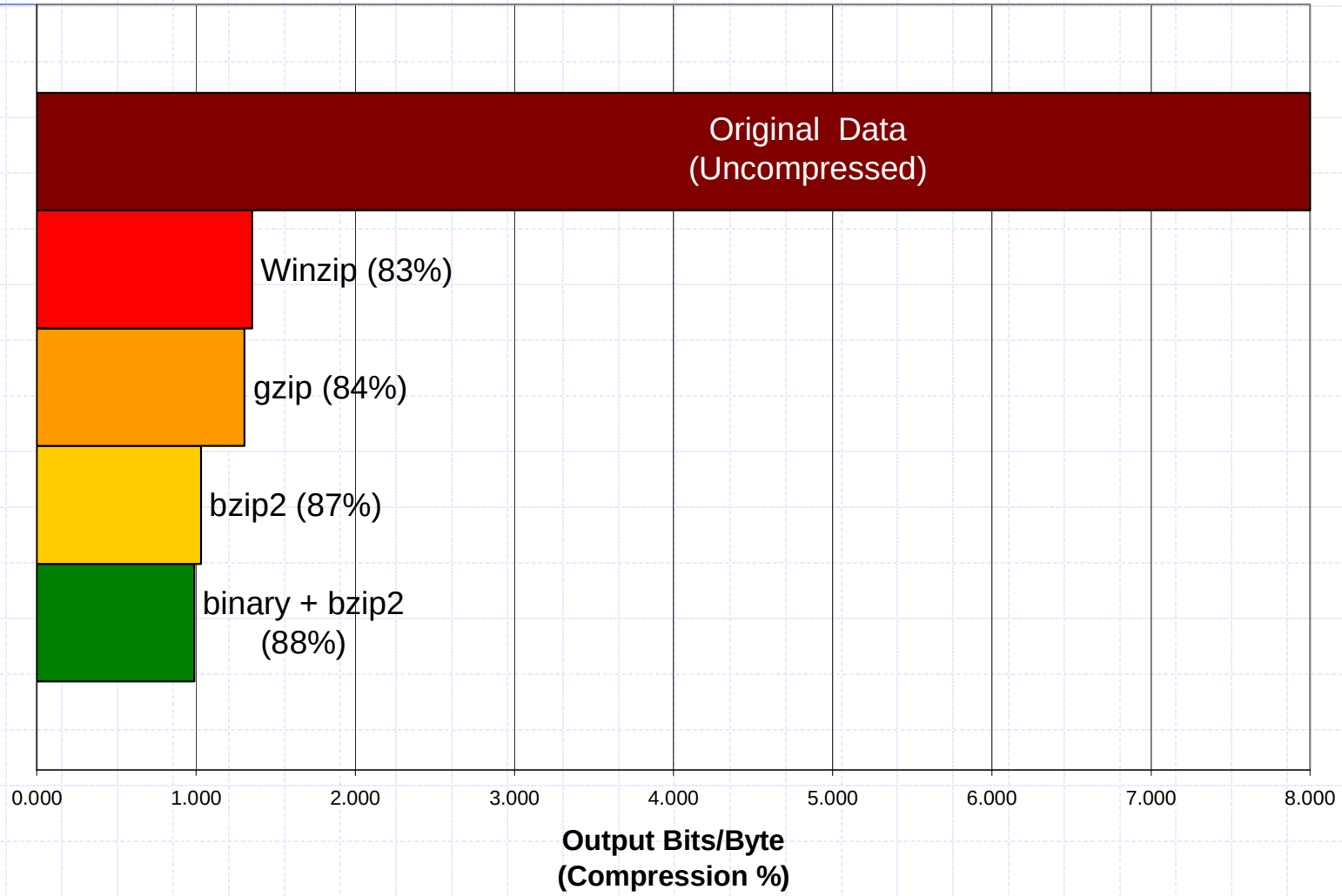
CompreX: Research Process

- Phase I of research developed proof-of-concept implementations for each aspect of the approach
  - Successful implementation of process
  - Encouraging results, led to award for Phase II work
- Phase II of research focusing on developing and enhancing work from Phase I
  - Currently examining binary encoder and compression algorithm tuning
  - Schema-based compression exploration just beginning
  - IDRC development to follow

CompreX: Schema Tag Example

- Analyze schema tags from document set
- Develop ordered list
- Replace verbose tags with index values
- Example:
  - Document Contains Tags: LATITUDE, LONGITUDE, ALTITUDE, SPEED, HEADING, etc.
  - Replace with indexed list: 0,1,2,3,5, ...
  - Immediate reduction in data transferred ~7:1
- Numerous other methods and reduction opportunities available

CompreX: Preliminary Results



Discussion/Questions?

Contacts:

- Kirk Swanson - Architecture Technology Corp:
  kswanson@atcorp.com 952-829-5864 x170
- Jason Judt - Architecture Technology Corp :
  jjudt@atcorp.com 952-829-5864 x137

Acknowledgements: This material is supported by the US Army under contract number W15P7T-04-P-A201.